

09/786001

Practitioner's Docket No. NITTA-4

CHAPTER II

TRANSMITTAL LETTER
TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/JP99/04662	27 August 1999 (27.08.99)	17 September 1998 (17.09.98)
International Application Number	International Filing Date	International Earliest Priority Date

TITLE OF INVENTION: WORKPIECE RETAINER AND METHOD FOR ATTACHING/DETACHING WORKPIECE BY USING THE SAME

APPLICANT(S): Tani, Naoyuki, et al.

Box PCT
Commissioner for Patents
Washington D.C. 20231
EO/US

CERTIFICATION UNDER 37 C.F.R. 1.10*

(Express Mail label number is mandatory.)

(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date February 28, 2001, in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number EJ852806575US, addressed to the: Commissioner for Patents, Washington, D.C. 20231.

C. Wayne S. Sampson
(type or print name of person mailing paper)

[Signature]
Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

***WARNING:** Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).
"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. § 371:

- a. This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).
- b. The U.S. National Fee (35 U.S.C. § 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS	9 -20 =	0	x \$18.00 =	\$0.00
	INDEPENDENT CLAIMS	3 -3 =	0	x \$80.00 =	\$0.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00				\$0.00
BASIC FEE	U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 C.F.R. § 1.492(a)(5)) \$860.00				\$860.00
	Total of above Calculations				= \$860.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable.				- \$0.00
	Subtotal				\$860.00
	Total National Fee				\$860.00
	Fee for recording the enclosed assignment document \$40.00 (37 C.F.R. § 1.21(h)).				- \$0.00
TOTAL	Total Fees enclosed				\$860.00

A check in the amount of \$860.00 to cover the above fees are enclosed.

3. A copy of the International application as filed (35 U.S.C. § 371(c)(2)) has been communicated by the International Bureau. Date of mailing of Notice Informing The Applicant Of The Communication Of The International Application To The Designated Office (from form PCT/IB/308): 30 March 2000.

4. Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)) have not been transmitted applicant chose not to make amendments under PCT Article 19.
Date of mailing of Search Report (from form PCT/ISA/210): 18 January 2000.
5. A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. § 371(c)(3)) has not been transmitted for reasons indicated in section 4.
6. A copy of the international examination report (PCT/IPEA/409) without Annexes is transmitted herewith.
7. An oath or declaration of the inventor (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115 is submitted herewith, and such oath or declaration is attached to the application.
- II. Other document(s) or information included:
8. An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a) is transmitted herewith.
9. Additional documents:
 - a. Copy of request (PCT/RO/101)
 - b. International Publication No. WO 00/17284
Specification, claims and drawing
 - c. Copy of Notice Informing The Applicant Of The Communication Of The International Application To The Designated Office (PCT/RO/308)
10. The above items are being transmitted before 30 months from any claimed priority date.

AUTHORIZATION TO CHARGE ADDITIONAL FEES

The Commissioner is hereby authorized to charge any additional fees, or to credit any overpayments, that may be required by this paper and during the entire pendency of this application to Account No.: 06-1075

Date: February 28, 2001

Reg. No. P-47,662
Tel. No.: (212) 596-9000



SIGNATURE OF PRACTITIONER

Nina R. Horan
Fish & Neave
1251 Avenue of the Americas
New York, NY 10020-1104
Customer No. 1473

09786001-060404

- 1 -

DESCRIPTION

WORKPIECE RETAINER AND5 METHOD FOR ATTACHING/DETACHING WORKPIECE BY USING THE SAME

TECHNICAL FIELD

10 The present invention relates to a workpiece
retainer which is attached to a base plate of a polishing
machine, etc., so as to hold a workpiece (e.g., a
semiconductor workpiece or precision glass) in place while
the workpiece is polished, and a method for
15 attaching/detaching a workpiece to/from the base plate of
a polishing machine, etc., by using the workpiece retainer.

BACKGROUND ART

20 In recent years, in the semiconductor industry, the
integration level of ICs has rapidly increased. It has
increased from 4M to 16M and is now proceeding to the 64M
level.

25 In light of the above circumstances, improvement in
the surface quality of a wafer (on which ICs are formed)
has been demanded. In order to increase the integration
level of ICs, it is necessary to reduce the minimum width
30 that is allowed for devices to be mounted on the wafer, as
well as improving the chemical and electrical properties
of the wafer. The ideal value for the minimum width has
shifted from about 0.5 microns to about 0.35 microns.

- 2 -

In order to enable such high-precision processing, more and more stringent demands have been made on the flatness or thickness accuracy of the wafer surface. Specifically, a wafer which has been subjected to a final mirror-surface polishing process is required to have a total thickness variation (TTV) on the order of 1 μm or less over the entire area, and a local thickness variation (LTV) on the order of 0.2 μm or less over an area of about 20 mm^2 (i.e., an area generally defining a single IC chip).

In order to satisfy such accuracy requirements, it is necessary to accurately mount a given wafer to be polished on a base plate of a polishing machine so that the wafer is substantially in parallel with respect to the base plate surface.

In general, wax is used for attaching a wafer on a polishing machine base plate. This method involves applying a fused wax on the surface of a heated base plate so as to allow the wafer to be fixed on the base plate surface via the applied wax.

According to this method, a wafer is first fixed on the base plate surface to carry out a polishing process; after the polishing process is completed, the base plate is heated again to fuse the wax thereon in order to remove the wafer from the base plate surface; and the wafer is washed with an organic solvent to eliminate the wax.

Although this method can provide a satisfactory small level of thickness variation of polished wafers, this method disadvantageously requires a heating step for causing

- 3 -

thermal fusing of wax, and large amounts of hazardous organic solvents for washing off the wax. Moreover, if any gelated substance or foreign particles are present in the wax, they may be transcribed as dimples on the wafer surface during the polishing process, thereby degrading the final polishing quality. Furthermore, the wafer surface may be slightly etched during the washing after polishing.

DISCLOSURE OF THE INVENTION

A workpiece retainer according to the present invention includes an adhesive composition containing a pressure-sensitive adhesive and a side-chain crystallizable polymer so that the side-chain crystallizable polymer is present in an amount of about 1% to about 30% by weight based on the adhesive composition, wherein the side-chain crystallizable polymer includes as a main component thereof an acrylic acid ester and/or methacrylic acid ester which has a straight-chain alkyl group including 16 or more carbon atoms as a side chain.

In one embodiment of the invention, the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight; and the adhesiveness of the adhesive composition is decreased by more than about 90% when heated above about 50°C.

In another embodiment of the invention, the side-chain crystallizable polymer has a molecular weight of about 2,000 to about 15,000.

In still another embodiment of the invention, the

- 4 -

adhesive composition exhibits sufficient tackiness with respect to a workpiece in a temperature range from room temperature to about 45°C, and is easily peeled off the workpiece above about 50°C.

5

In still another embodiment of the invention, the side-chain crystallizable polymer has a melting point which occurs within a temperature range narrower than about 15°C.

10

Alternatively, the workpiece retainer according to the present invention includes: a first pressure-sensitive adhesive layer on which a workpiece is to be attached; a support formed on a back face of the first pressure-sensitive adhesive layer; and a second pressure-sensitive adhesive layer formed on a back face of the support, wherein the first pressure-sensitive adhesive layer includes an adhesive composition, the adhesive composition containing a pressure-sensitive adhesive and a side-chain crystallizable polymer so that the side-chain crystallizable polymer is present in an amount of about 1% to about 30% by weight based on the adhesive composition, and the side-chain crystallizable polymer including as a main component thereof an acrylic acid ester and/or methacrylic acid ester which has a straight-chain alkyl group including 16 or more carbon atoms as a side chain.

15

20

25

In one embodiment of the invention, the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight; and the adhesiveness of the adhesive composition is decreased by more than about 90% when heated above about 50°C.

30

In another embodiment of the invention, the

- 5 -

side-chain crystallizable polymer has a molecular weight of about 2,000 to about 15,000.

5 In still another embodiment of the invention, the adhesive composition exhibits sufficient tackiness with respect to a workpiece in a temperature range from room temperature to about 45°C, and is easily peeled off the workpiece above about 50°C.

10 In still another embodiment of the invention, the side-chain crystallizable polymer has a melting point which occurs within a temperature range narrower than about 15°C.

15 In another aspect of the invention, there is provided a method for attaching/detaching any of the above workpiece retainers to/from a base plate of a polishing machine, including the steps of: attaching the workpiece retainer to at least one of the workpiece and the base plate of the polishing machine maintained at temperature T1; and
20 detaching the workpiece from the base plate by heating the workpiece retainer at temperature T2 which is higher than temperature T1.

25 The present invention provides the following effects.

According to one embodiment of the present invention, a workpiece retainer is provided which is composed essentially of an adhesive composition containing a
30 pressure-sensitive adhesive and a side-chain crystallizable polymer, where the side-chain crystallizable polymer is present in the amount of about 1% to about 30% by weight based on the adhesive composition.

- 6 -

The side-chain crystallizable polymer includes as a main component thereof an acrylic acid ester and/or methacrylic acid ester which has a straight-chain alkyl group including 16 or more carbon atoms as a side chain. As a result, the polymer is capable of shifting between a crystal state and an amorphous state in a reversible manner, responsive to a relatively small temperature change from an arbitrarily selected ordinary temperature value; consequently, the polymer exhibits drastic a change in its tackiness to a workpiece which it is adhered to.

Thus, when the workpiece retainer is heated to a predetermined elevated temperature (e.g., about 50°C to about 100°C), the adhesiveness of the adhesive layer rapidly decreases. Therefore, at the time of peeling a workpiece from the workpiece retainer, the workpiece retainer (and/or any work substrate on which the workpiece retainer is attached, e.g., an upper base plate) may be heated so as to greatly decrease the adhesiveness of the adhesive layer with respect to the workpiece, whereby the workpiece retainer can be easily peeled off the workpiece.

In accordance with an embodiment of the invention where the adhesive composition contains a tackifier in the amount of about 10% to about 30% by weight and where the adhesiveness of the adhesive composition is decreased by more than about 90% when heated above about 50°C, a predetermined level of adhesiveness with respect to the workpiece such as a wafer can be retained at ordinary temperatures, whereas a rapid decrease in adhesion strength can be caused by heating. Thus, a tackifier present in the above-mentioned amount will not substantially influence the temperature sensitivity of the polymer. As a result, the

- 7 -

adhesive composition according to the present invention exhibits a sufficient adhesion strength at ordinary temperatures, while maintaining a good balance between the adhesion strength at ordinary temperatures and the peeling force required at elevated temperatures.

Thus, the invention described herein makes possible the advantages of (1) providing a workpiece retainer which allows a workpiece to adhere strongly, stably, and precisely to a base plate of a polishing machine, and yet allows for easy detachment of the workpiece from the base plate, without requiring washing with any conventional organic solvents and/or surfactants; (2) providing a method for attaching/detaching a workpiece by using the workpiece retainer.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view illustrating a workpiece retainer according to one example of the present invention when attached to an upper base plate of a polishing machine, with a wafer adhered to the workpiece retainer.

Figure 2 is a cross-sectional view illustrating a workpiece retainer according to another example of the present invention when attached to an upper base plate of a polishing machine, with a wafer adhered to the workpiece

- 8 -

retainer.

BEST MODES FOR CARRYING OUT THE INVENTION

5 The workpiece retainer according to the present invention is composed essentially of an adhesive composition containing a side-chain crystallizable polymer having a melting point which occurs within a temperature range
10 narrower than about 15°C and a pressure-sensitive adhesive. The adhesive composition exhibits adhesive properties at an ordinary temperature T1 (generally below about 40°C to 50°C), and yet exhibits much reduced adhesiveness to a workpiece or other material when heated to an elevated
15 temperature T2 which is higher than the ordinary temperature T1 by about 15°C or more.

As shown in Figure 1, the workpiece retainer 1 of the present invention may compose a single layer upon a work
20 substrate such as a base plate of a polishing machine. Alternatively, as shown in Figure 2, the workpiece retainer 1 may include three layers with a support interposed in the middle. As illustrated in Figure 2, the three-layered workpiece retainer may include a first
25 pressure-sensitive adhesive layer 2 (composed of the inventive adhesive composition) formed on one face of a support sheet 3 and a second pressure-sensitive adhesive layer 4 formed on the other face of the support sheet 3.

30 The second pressure-sensitive adhesive layer 4 may be composed essentially of (1) a commercially available pressure-sensitive adhesive, (2) a mixture of a commercially available pressure-sensitive adhesive and the inventive

09786001.080401

- 9 -

adhesive composition, or (3) a pressure-sensitive adhesive of a temperature-sensitive type whose adhesiveness can be reduced responsive to cooling.

5 (Pressure-sensitive Adhesive layer)

Examples of pressure-sensitive adhesives contained in the adhesive composition of the present invention include the following materials: natural rubber adhesives; styrene/butadiene latex-base adhesives; ABA block
10 copolymer type thermoplastic rubbers (where A represents a thermoplastic polystyrene end block; and B represents a rubber intermediate block such as polyisoprene, polybutadiene or poly(ethylene/butylene)); butyl rubber; polyisobutylene; acrylic adhesives such as polyacrylate and
15 vinyl acetate/acryl ester copolymer; and vinylether copolymers such as polyvinylmethylether, polyvinylethylether, and polyvinylisobutylether.

Especially preferable are acryl type pressure-sensitive adhesives composed essentially of ethylhexyl
20 acrylate, hydroxyethyl acrylate, or the like. The use of acryl type pressure-sensitive adhesives provides interaction with the polymer such that the polymer will so be sufficiently dispersed within the adhesive layer at a
25 predetermined temperature so as to exhibit sufficient tackiness, and yet that the polymer will easily bleed out when heated to a temperature above the predetermined temperature.

30 (Side-chain Crystallizable Polymer)

As a side-chain crystallizable polymer to be contained in the adhesive composition, those which have a melting point which occurs within a temperature range

09786001-060401

- 10 -

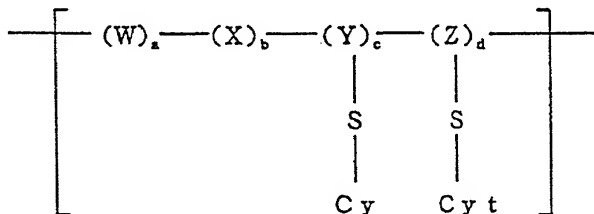
narrower than about 15°C (also referred to as "first-order melting transition") are preferably used. An adhesive composition containing such a polymer is disclosed in Japanese National Phase PCT Laid-open Publication No. 6-510548.

As used herein, the term "melting point" means the temperature at which an equilibrium process causes certain portions of a polymer, initially aligned in an ordered array, to become disordered. In one embodiment, preferably, the melting point of the polymer is in the range of about 40°C to about 100°C, more preferably in the range of about 40°C to 60°C. It is preferable that the melting occur rapidly, i.e., over a relatively narrow temperature range which is less than about 10°C and preferably less than about 5°C. It is preferable that the polymer crystallizes rapidly. To this end, seeding agents, or crystallization catalysts can be incorporated into the polymer.

After use, the workpiece retainer according to the present invention can be readily peeled off the surface of the polishing machine base plate by simply heating the workpiece retainer to a temperature (hereinafter referred to as an "elevated temperature") which is slightly higher than the use temperature. The elevated temperature is usually about 40°C to about 100°C, preferably about 40°C to about 70°C, and more preferably about 50°C to about 70°C.

The present invention is based on the finding that it is possible to obtain an adhesive composition whose adhesiveness controllably varies with temperature by mixing a crystallizable polymer of certain physicochemical properties with a pressure-sensitive adhesive.

The most preferable side-chain crystallizable polymer to be used according to the present invention contains repeating units of the formula below:



... (I)

In formula (I), W and X represent first and second monomer units, respectively, each of which may be any molecular moiety connectable to an adjoining molecular moiety (i.e., polymerizable). Y and Z each independently represent a backbone monomer unit which may be any molecular moiety or atom. Each S independently represents a linking group or spacer unit which may optionally be present. Cyt and Cy each independently represent a crystallizable moiety which is connected to the respective backbone either directly or via the spacer unit. Variables a, b, c, and d each independently represent an integer in the range of 0 to 1,000 with the proviso that sufficient Cyt and Cy are present so as to provide a molecular weight which is equal to or greater than twice the sum of the molecular weights of W, X, Y and Z. The polymers have a heat of fusion (ΔH_f) of at least about 20 Joules/g. In the case where variables a, b, c, and d are all greater than 1, monomer units W, X, Y, and Z each define a repeating unit or a mixture of different monomer units. For example, in the case where

Figure 1 illustrates the experimental design. It shows a sequence of events for a single trial: a stimulus (a 3x3 grid of numbers), a response (a number), feedback (a number), and a reward (a number). The sequence is repeated for multiple trials.

- 12 -

a is 100, W may be a 5:5:2:5:83 mixture of styrene, acrylic acid, methylstyrene, and hexadecylacrylate. Accordingly, any of monomer units W, X, Y, and Z may be a mixture of polymerizable monomers.

5

The adhesive composition according to the present invention may optionally be cross-linked. Cross-linking may be effected by any known technique, such as using a cross-linking agent, heating, or radiation.

10

The backbone of the polymer (represented as W, X, Y, and Z in formula (I)) may be any organic structure (aliphatic or aromatic hydrocarbon, ester, ether, amide, etc.) or an inorganic structure (sulfide, phosphazine, silicone, etc.). The spacer linkages can be any suitable organic or inorganic units, for example, ester, amide, hydrocarbon, phenyl, ether, or inorganic salt (e.g., a carboxyl-alkyl ammonium or sulphonium or phosphonium ion pair, or other known ionic salt pair). The side-chain (represented as Cyt and Cy, and an optionally present S in formula (I)) may be aliphatic or aromatic, or a combination of aliphatic side-chains of at least 10 carbon atoms, fluorinated aliphatic side-chains of at least 6 carbon atoms, and p-alkyl styrene side-chains wherein the alkyl group contains 8 to 24 carbon atoms.

15

20

25

The length of each side-chain moiety is usually greater than about 5 times the distance between side-chains in the case of acrylates, methacrylates, vinyl esters, acrylamides, methacrylamides, vinyl ethers, and alpha olefins. In the extreme case of a fluoroacrylate alternate copolymer with butadiene, a side-chain can be as little as 2 times the length of the distance between branches. In any

30

097866001-0660401

- 13 -

case, the side-chain unit should account for more than about 50% of the volume of the polymer, preferably greater than about 65% of the volume. Co-monomers added to a side-chain polymer usually have an adverse effect on crystallinity. Small amounts (usually about 10% to about 25% by volume) of various comonomers can be tolerated. In some cases, it may be preferable to add a small amount of comonomer, e.g., a cure site monomer such as acrylic acid, glycidial methacrylate, maleic anhydride, an amino functional monomer, and the like.

Examples of side-chain crystallizable monomers which fall within the above-described categories include acrylate, fluoroacrylate, methacrylate and vinyl ester polymers such as those described in J. Poly. Sci. 10: 3347 (1972); J. Poly. Sci. 10: 1657 (1972); J. Poly. Sci. 9: 3367 (1971); J. Poly. Sci. 9: 3349 (1971); J. Poly. Sci. 9: 1835 (1971); J.A.C.S. 76: 6280 (1954); J. Poly. Sci. 7: 3053 (1969); J. Poly. Sci. 17: 991 (1985), corresponding acrylamides, substituted acrylamide and maleimide polymers (J. Poly. Sci.: Poly. Physics Ed. 18: 2197 (1980); poly(α -olefin) polymers such as those described in J. Poly. Sci.: Macromol. Rev. 8: 117-252 (1974) and Macromolecules 13: 12 (1980), polyalkyl-vinylethers, polyalkylethylene oxides such as those described in Macromolecules 13: 15 (1980), alkylphosphazene polymers, polyamino acids such as those described in J. Poly. Sci. USSR 21: 241 (1979), Macromolecules 18: 2141(1985), polyisocyanates such as those described in Macromolecules 12: 94 (1979), polyurethanes made by reacting amine- or alcohol-containing monomers with long-chain alkyl isocyanates, polyesters and polyethers, polysiloxanes and polysilanes such as those described in Macromolecules 19: 611 (1986), and p-

- 14 -

alkylstyrene polymers such as those described in J.A.C.S. 75: 3326 (1953), and triglycerides such as tristearin or pentaerythritol tetrastearate.

5 Particularly preferable side-chain crystallizable polymers to be used for the present invention include linear aliphatic C14-C50 (having 14 to 50 carbon atoms) polyacrylates, linear aliphatic C14-C50 polymethacrylates, linear aliphatic C14-C50 polyacrylamides, and linear
10 aliphatic C14-C50 polymethacrylamides. Especially preferable among these are linear aliphatic C16-C22 polyacrylates, linear aliphatic C16-C22 polymethacrylates, linear aliphatic C16-C22 polyacrylamides, and linear aliphatic C16-C22 polymethacrylamides.

15 As described above, the melting point of the selected crystallizable polymer defines a use temperature range, within which the composition exhibits tackiness. The amount of the crystallizable polymer incorporated in
20 the adhesive composition has surprisingly little effect on the position or the breadth of this range.

The transition temperatures of some selected side-chain crystallizable polymers are listed below:

polymer	transition temperature (°C)
C16 acrylate	36
C16 methacrylate	26
C18 acrylate	49
C18 methacrylate	39
C20 acrylate	60
C20 methacrylate	50

- 15 -

C22 acrylate	71
C22 methacrylate	62

5 See E. F. Jordan et al. "SIDE-CHAIN CRYSTALLIZATION
DEGREE II", J. Poly. Sci. Section A-1, 9: 33551 (1971).
Examples in this literature describe a method for producing
a crystallizable polymer in detail.

10 The molecular weight of the crystallizable polymer
to be used is an important factor that determines the manner
in which the adhesive composition of the present invention
exhibits temperature-dependent tackiness and/or adhesion
strength. Specifically, a low molecular weight
crystallizable polymer will advantageously lose bonding
15 strength when heated. If such property is desirable, the
molecular weight of the polymer is preferably in the range
of 2,000 to 15,000, and more preferably in the range of 3,000
to 10,000.

20 The adhesive compositions useful for the present
invention may contain, in addition to one or more of the
polymers described above, conventional additives such as
tackifiers (wood rosin, polyesters, etc.), antioxidants,
fibrous or non-fibrous fillers, colorants, and the like.
25 It is also possible to include additional adhesives in the
adhesive composition so long as the overall temperature
sensitivity profile is not significantly affected thereby.
The amount of crystallizable polymer in the adhesive
composition is preferably in the range of about 1% by weight
30 to about 30% by weight, more preferably in the range of about
5% by weight to about 20% by weight, and in particular in
the range of about 5% by weight to about 15% by weight. If
the polymer content in the adhesive composition is less than

09786004-060401
104090-1009260

- 16 -

about 1% by weight or more than about 30% by weight, the above-described effects of the polymer may not be exhibited.

The adhesive compositions of the present invention may be prepared by admixing a pressure-sensitive adhesive and a crystallizable polymer in a compatible solvent and adding optional components thereto, e.g., a plasticizer, a tackifier, and/or a filler. The solid contents are adjusted to the desired viscosity, and the mixture is blended until it is homogeneous. After blending, bubbles are removed from the mixture.

Examples of tackifiers include special rosin ester type tackifiers, terpene phenol type tackifiers, petroleum resin type tackifiers, high hydroxyl value rosin ester type tackifiers, hydrogenated rosin ester type tackifiers, and the like. Examples of commercial products include a special rosin ester type tackifier designated Super Ester A125 (Arakawa Chemical K.K.), a terpene phenol type tackifier designated Tamanoru 803L (Arakawa Chemical K.K.), a petroleum resin type tackifier designated Hiresin #90S (Toho Chemical Industry Co. Ltd.), a high hydroxyl value rosin ester type tackifier designated KE-364C (Arakawa Chemical K.K.), and a hydrogenated rosin ester type tackifier designated Estergum HD (Arakawa Chemical K.K.).

Particularly preferable are, special rosin ester type tackifiers. The amount of a tackifier to be added is preferably in the range of about 10% to about 30% by weight, more preferably about 15% to about 25%, based on the adhesive composition. If the tackifier content is less than about 10% by weight, sufficient adhesion strength may not be attained at ordinary temperatures. If the tackifier

- 17 -

content is more than about 30% by weight, the rate of decrease of adhesion strength may not be sufficient at the time of peeling.

5 Preferable examples of a polymer contained in the adhesive composition include the following:

10 (1) a copolymer of 80 to 98 parts by weight of stearyl acrylate, 2 to 20 parts by weight of acrylic acid, and 2 to 10 parts by weight of dodecylmercaptan;

15 (2) a copolymer of 5 to 90 parts by weight of dococyl acrylate, 5 to 90 parts by weight of stearyl acrylate, 1 to 10 parts by weight of acrylic acid, and 2 to 10 parts by weight of dodecylmercaptan; and

20 (3) a copolymer of 80 to 98 parts by weight of dococyl acrylate, 2 to 20 parts by weight of acrylic acid, and 2 to 10 parts by weight of dodecylmercaptan.

25 Examples of pressure-sensitive adhesives to be contained in the adhesive composition include a copolymer containing 80 to 95 parts by weight of 2-ethylhexyl acrylate and 5 to 20 parts by weight of 2-hydroxyethyl acrylate.

(Support sheet)

30 As the support sheet 3, various synthetic resin sheets can be used, e.g., polyethylene terephthalate, polyether imide, or polyurethane. For example, a polyester film designated "Lumirror" (manufactured by Toray Industries, Inc.) may be used.

A number of methods can be used to provide the

- 18 -

adhesive composition of the invention on a work substrate (such as a base plate of a polishing machine) or on a workpiece, e.g., spray deposition, painting, dipping, gravure printing, rolling or the like. The polymer composition may also be transferred from a release sheet, as in the manner of transfer printing. The composition may be applied neat (i.e., without anything else), or in a suitable solvent, or as an emulsion or latex. Alternatively, a mixture of appropriate monomers and additives may be applied directly to a substrate and cured in situ by heat, irradiation, or other suitable processes known in the art.

In the case of composing the workpiece retainer of three or more layers, the above-described pressure-sensitive adhesive layer may be laminated on one or both faces of a support, and a second pressure-sensitive adhesive layer may be laminated on the other face of the support. The pressure-sensitive adhesive used for the inventive pressure-sensitive adhesive layer may be used as the second pressure-sensitive adhesive, for example; however, any commercially available adhesive, in particular a rubber type adhesive, an acrylic type adhesive, or a semi-hotmelt adhesive can be used as the second pressure-sensitive adhesive.

(Method for attaching/detaching a workpiece)

By using the workpiece retainer of the present invention, the attachment/detachment of a workpiece to/from a base plate of a polishing machine can be performed as follows, for example.

First, the polishing machine base plate is removed and cleaned. The workpiece retainer may be applied on the

- 19 -

base plate by means of a spin-coater. In the case of processing a plate-like workpiece, the workpiece retainer may be similarly applied on the workpiece by means of a spin-coater. Next, either the workpiece or the base plate, or both, is pressed onto the workpiece retainer at an ordinary temperature (e.g., about 20°C to 30°C). In the case of polishing a semiconductor wafer, it is preferable to slightly warp the workpiece retainer and gently press it against the workpiece so that its central portion contacts the workpiece first.

After attaching a workpiece on a polishing machine base plate in any of the above-described manners for a desired process of the workpiece, the workpiece may be removed by heating the base plate carrying the workpiece retainer attached thereon to an elevated temperature above about 50°C, for example. Following heating methods can be used, for example:

(1) Methods for heating the workpiece retainer

These methods may involve application of a heated iron, hot water, a heater sheet, hot air (e.g., from an air heater or a drier), steam, radiofrequency heating, and/or irradiation (infrared or far-infrared) by means of a lamp, for example.

(2) Methods for applying heat at the interface between the workpiece retainer and the base plate

These methods may involve application of a heated trowel, a heated iron, hot air (e.g., from an air heater or a drier), hot water, steam, and/or irradiation (infrared or far-infrared) by means of a lamp, for example.

(3) Methods for heating the base plate

These methods involve storing the base plate in an isothermal room kept at about 50°C to about 100°C, or immersing the base plate in hot water kept at about 50°C or above. Thereafter, the heated workpiece retainer can be peeled off the base plate. Since the peeling force at the elevated temperature is decreased to about 0.1 to about 0.5 Kg/inch width, the workpiece retainer of the present invention can be easily peeled off the base plate surface. The peeling of the workpiece retainer may be performed manually.

The polymer composition containing polymers exhibiting the above-defined temperature-dependent adhesion profile can be utilized for a workpiece retainer for polishing lenses, prisms or other precision-ground glass articles. Alternatively, it is possible to previously apply the polymer composition to a small but uniform thickness on a thin substrate sheet, peel the substrate sheet off the polymer composition, and adhere and secure the polymer composition onto a workpiece.

By attaching a workpiece on a base plate by means of the workpiece retainer of the invention (temperature-dependent pressure-sensitive retainer) containing polymers exhibiting the above-defined temperature-dependent adhesion profile, the washing step following a polishing process, if any, can be remarkably facilitated, and the quality of the processed surface can be remarkably facilitated as compared to employing a conventional wax or pressure-sensitive adhesive.

- 21 -

Hereinafter, the present invention will be specifically described by way of illustrative examples. In the following description, any reference to "part(s)" means

5 "part(s) by weight".

A. Preparation of polymer

(Synthesis Example 1)

10 First, 95 parts of stearyl acrylate, 5 parts of acrylic acid, 5 parts of dodecylmercaptan, and 1 part of Kayaester HP-70 (Kayaku Akzo K.K.) were mixed. The mixture was stirred at about 80°C for about 5 hours to polymerize these monomers. The resultant polymer had a molecular

15 weight of about 8,000, and a melting point of about 50°C.

(Synthesis Example 2)

20 First, 92 parts of 2-ethylhexyl acrylate, 8 parts of hydroxyethyl acrylate, and 0.3 parts of Trigonox 23-C70 (Kayaku Akzo K.K.) were mixed in 150 parts of ethyl acetate/heptane (70/30). The mixture was stirred at 55°C for 3 hours and heated to about 80°C, and 0.5 parts of Kayaester HP-70 was added. The mixture was stirred for about

25 2 hours to polymerize these monomers. The resultant polymer had a molecular weight of about 600,000.

B. Preparation of a workpiece retainer

(Example 1)

30 The polymers obtained in accordance with Synthesis Examples 1 and 2 were mixed at a ratio of 10: 100 parts. To the resultant polymer solution, a cross-linking agent designated Coronate L45 (Nippon Polyurethane Industry Co.,

- 22 -

Ltd.) was added so that 0.3 parts of Coronate L45 was present against 100 parts of the polymer of Synthesis Example 2. As shown in Figure 2, the resultant mixture was coated on both faces of a support 3 (a PET film manufactured by Somar Co.) so as to have a dry thickness of about 40 μm , thereby forming an double-sided adhesive tape.

As a workpiece retainer 1, the double-sided adhesive tape was attached to a ceramic base plate 5 of a polishing machine. A silicon wafer 6 (diameter: about 8 inches) was directly attached to the workpiece retainer 1 at an adhesion temperature of about 25°C. Thereafter, the wafer was subjected to a polishing under the polishing conditions described in Table 1. After the polishing was finished, the wafer attached to the ceramic carrier was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer was peeled off the ceramic carrier. Thereafter, it was confirmed by eyesight that no substantial artifacts of residual organic matter had been left on the wafer back face. The double-sided adhesive tape peeled off the ceramic upper base plate with a maximum peeling force of about 1.3 Kg.

(Example 2)

A polymer mixture was prepared in the same manner as in Example 1 except that the cross-linking agent Coronate L45 (Nippon Polyurethane Industry Co., Ltd.) was added so that 0.5 parts of Coronate L45 was present against 100 parts of the polymer of Synthesis Example 2. The polymer mixture was directly coated on a ceramic carrier of a polishing machine so as to have a thickness of about 0.02 μm by means of a spin-coater, thereby forming a workpiece retainer. A silicon wafer was attached to the

- 23 -

workpiece retainer at an adhesion temperature of about 25°C. Thereafter, the wafer was subjected to a polishing under the polishing conditions described in Table 1. After the polishing was finished, the wafer attached to the ceramic carrier was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer was peeled off the ceramic carrier. Thereafter, it was confirmed by eyesight that no substantial artifacts of residual organic matter had been left on the wafer back face.

(Example 3)

A double-sided adhesive tape was produced in the same manner as in Example 1 except that Superester A125 (Arakawa Chemical K.K.) was added as a tackifier in the amount of about 20% by weight based on the polymer of Synthesis Example 1.

Next, using the resultant double-sided adhesive tape, the wafer was subjected to the same polishing test as in Example 1. After the polishing was finished, the wafer attached to the ceramic carrier was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer was peeled off the ceramic carrier. Thereafter, no substantial clouding due to residual organic matter was observed on the back face of the silicon wafer.

(Example 4)

The double-side adhesive tape used in Example 3 was directly attached to a 20 mm×20 mm prism (manufactured by BK7), and press-attached to an upper base plate of a polishing machine at an adhesion temperature of about 25°C. Thereafter, the prism was subjected to a polishing under the polishing conditions described in Table 2. After the

- 24 -

polishing was finished, the prism attached to the upper base plate was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer was peeled off the upper base plate. Thereafter, the light transmittance measurement of this prism showed a sufficiently high value.

(Example 5)

First, 45 parts of cetyl acrylate, 50 parts of methylacrylate, 5 parts of acrylic acid, and 0.5 parts of azobisisobutyronitrile were mixed in toluene. The mixture was stirred at about 60°C for 10 hours under a nitrogen atmosphere to polymerize these monomers. The resultant polymer had a molecular weight of about 700,000. The transition temperature of the resultant polymer from a non-tacky state to a tacky state was in the range of about 10°C to about 20°C. The polymer exhibited no finger-felt tackiness below about 10°C, indicative of extremely low adhesiveness.

A double-sided adhesive tape was produced in the same manner as in Example 1 except that the pressure-sensitive adhesive layer 4 was formed by coating the above-described polymer so as to have a dry thickness of about 45 μ m (Figure 2).

Next, by using the resultant double-sided adhesive tape, the same polishing test as in Example 1 was performed. After the polishing was finished, in a manner similar to Example 1, the wafer 6 attached to the ceramic carrier 5 was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer 6 was peeled off the ceramic carrier 5. At this point, the base plate 5 and the pressure-sensitive adhesive layer 4 were well-adhered,

- 25 -

whereas the pressure-sensitive adhesive layer 2 easily peeled at the interface with the silicon wafer 6. Thereafter, no substantial clouding was observed on the back face of the silicon wafer. By further cooling the base plate 5 to about 5°C, the pressure-sensitive adhesive layer 4 easily peeled off the base plate 5.

(Example 6)

A double-sided adhesive tape was produced in the same manner as in Example 1 except that the pressure-sensitive adhesive layer 4 was formed by coating a commercially available rubber type adhesive (NO-TAPE Industrial Co., Ltd.) so as to have a dry thickness of about 45 µm (Figure 2).

Next, by using the resultant double-sided adhesive tape, the same polishing test as in Example 1 was performed. After the polishing was finished, in a manner similar to Example 1, the wafer 6 attached to the ceramic carrier 5 was held under a flow of pure water heated to about 60°C for about 5 minutes, whereby the wafer 6 was peeled off the ceramic carrier 5. At this point, the pressure-sensitive adhesive layer 2 easily peeled at the interface with the silicon wafer 6. Thereafter, no substantial clouding was observed on the back face of the silicon wafer.

Furthermore, a silicon wafer was attached to the pressure-sensitive adhesive layer 2, and the same polishing test as in Example 1 was performed. Thereafter, the silicon wafer was peeled while being heated. At this point, the base plate 5 and the pressure-sensitive adhesive layer 4 were well-adhered, whereas the pressure-sensitive adhesive layer 2 easily peeled at the interface with the silicon

- 26 -

wafer 6.

A series of processes consisting of attachment of a silicon wafer, a polishing test, heating, and peeling was repeated three times. The silicon wafer did not peel off the pressure-sensitive adhesive layer 2 during the polishing test, indicative of practically satisfactory adhesiveness. No substantial clouding was observed on the back face of the silicon wafer.

(Comparative Example 1)

A polishing test was performed under the same conditions as in Example 1 except for using a double-sided adhesive tape ST442 (Sumitomo 3M Ltd.) instead of the double-sided adhesive tape according to Example 1.

After the polishing test was finished, it was difficult to peel the wafer. The double-sided adhesive tape peeled off the ceramic upper base plate with a maximum peeling force of about 14.3 Kg.

(Comparative Example 2)

As in Example 2, a water-soluble wax for semiconductor wafers (viscosity: 10 cps; solid content: 10%) was directly coated on a ceramic carrier of a polishing machine so as to have a thickness of about 0.20 μm by means of a spin-coater, and a silicon wafer was attached to this composite at an adhesion temperature of about 80 $^{\circ}\text{C}$. Thereafter, the wafer was subjected to a polishing under the polishing conditions described in Table 1. After the polishing was finished, the wafer attached to the ceramic carrier was peeled by means of a pick, and then washed with pure water. An eyesight inspection of the residual organic

- 27 -

matter on the wafer back face revealed the presence of residual wax, indicative of the need to wash the wafer with an organic solvent.

5 (Comparative Example 3)

10 A commercially available rosin wax (viscosity: 100 cps; solid content: 50%) was directly applied on a 20 mm × 20 mm prism (manufactured by BK7), and press-attached to an upper base plate of a polishing machine at an adhesion temperature of about 100°C. Thereafter, the prism was subjected to a polishing under the polishing conditions described in Table 2. After the polishing was finished, the prism attached to the upper base plate was heated so as to be peeled off the upper base plate. Thereafter, the light transmittance measurement of this prism showed a very low value due to the presence of a large amount of residual wax, 15 indicative of the need to wash the prism.

09785001-060401
104090-100826

- 28 -

Table 1

Polishing machine	Speed fam Single-side polishing machine (59SPAW) with a base plate
Wafer to be processed	Silicon monocrystal P (100) wafer (diameter: 8 inches)
Polishing cloth	SUBA800
Polishing slurry	NALCO2350; diluted by 20 times (manufactured by Nalco Chemical Company)
Processing pressure	300 g/cm ²
Slurry flow rate	1000 ml/min.
Processing time	30 min.

09786001-060403
104090-10098260

- 29 -

Table 2

Polishing machine	Speed fam Single-side polishing machine (26B) with a base plate
workpiece retainer to be processed	prism (manufactured by BK7; 20 mm × 20 mm)
Polishing cloth	MH C14A-15
Polishing slurry	cerium oxide, Mireku S0; 20 wt%
Processing pressure	150 g/cm ²
Slurry flow rate	500 ml/min. (used with circulation)
Processing time	20 min.

INDUSTRIAL APPLICABILITY

5

Thus, according to the present invention, it is possible to adjust the tackiness of a workpiece retainer with respect to a workpiece simply by changing the temperature of the workpiece retainer. As a result, it is possible to adhere a workpiece strongly, stably, and precisely to a base plate of a polishing machine during

10

09786001-060401

- 30 -

5 polishing by maintaining the workpiece retainer at a temperature (which may usually be room temperature) at which it exhibits satisfactory tackiness, whereas it is still easy to detach the workpiece from the base plate by appropriately heating the workpiece retainer. Thus, the workpiece is protected from contamination and/or etching due to organic solvents and/or surfactants as in the prior art, thereby providing for high-quality final polishing state.

10 Furthermore, the exchanging or replacement of a workpiece retainer according to the present invention, conducted after each polishing process, is facilitated because the workpiece retainer can be easily peeled off a base plate surface simply through temperature adjustment.

15 Since the tackiness of the workpiece retainer according to the present invention with respect to the workpiece can be changed in a reversible manner simply through temperature adjustment, it is possible to
20 repetitively attach and detach a workpiece to and from the workpiece retainer. For example, it is possible to subject silicon wafers to repetitive polishing processes on a workpiece retainer affixed to a base plate.

25 Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth
30 herein, but rather that the claims be broadly construed.

09786001.060401

NI008

- 31 -

CLAIMS

1. (Amended) A workpiece retainer comprising an adhesive composition containing a pressure-sensitive adhesive and a side-chain crystallizable polymer so that the side-chain crystallizable polymer is present in an amount of about 1% to about 30% by weight based on the adhesive composition,

wherein the side-chain crystallizable polymer includes as a main component thereof an acrylic acid ester and/or methacrylic acid ester which has a straight-chain alkyl group including 16 or more carbon atoms as a side chain.

wherein the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight, and wherein the side-chain crystallizable polymer has a molecular weight of about 2,000 to about 15,000.

2. (Amended) A workpiece retainer according to claim 1,

[wherein the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight; and]

wherein adhesiveness of the adhesive composition, measured by a peeling force, is decreased by more than about 90% when heated above about 50°C, with respect to the adhesiveness when measured at 25°C.

3. [CANCELED]

4. A workpiece retainer according to claim 1,

wherein the adhesive composition exhibits sufficient tackiness with respect to a workpiece in a temperature range from room temperature to about 45°C, and is easily peeled off the workpiece above 50°C.

5. A workpiece retainer according to claim 1, wherein the

NI008

- 31/1 -

side-chain crystallizable polymer has a melting point which occurs within a temperature range narrower than about 15°C.

09786001-000119

NI008

- 32 -

6. (Amended) A workpiece retainer comprising:

a first pressure-sensitive adhesive layer on which a workpiece is to be attached;

a support formed on a back face of the first pressure-sensitive adhesive layer; and

a second pressure-sensitive adhesive layer formed on a back face of the support,

wherein the first pressure-sensitive adhesive layer comprises an adhesive composition,

the adhesive composition containing a pressure-sensitive adhesive and a side-chain crystallizable polymer so that the side-chain crystallizable polymer is present in an amount of about 1% to about 30% by weight based on the adhesive composition, and

the side-chain crystallizable polymer including as a main component thereof an acrylic acid ester and/or methacrylic acid ester which has a straight-chain alkyl group including 16 or more carbon atoms as a side chain.

wherein the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight, and

wherein the side-chain crystallizable polymer has a molecular weight of about 2,000 to about 15,000.

7. (Amended) A workpiece retainer according to claim 6,

[wherein the adhesive composition contains a tackifier in an amount of about 10% to about 30% by weight; and]

wherein adhesiveness of the adhesive composition, measured by a peeling force, is decreased by more than about 90% when heated above about 50°C, with respect to the adhesiveness when measured at 25°C.

8. [CANCELED]

NI008

- 32/1 -

9. A workpiece retainer according to claim 6,

wherein the adhesive composition exhibits sufficient tackiness with respect to a workpiece in a temperature range

00786001 060401
104090 10090260

NI008

- 33 -

from room temperature to about 45°C, and is easily peeled off the workpiece above 50°C.

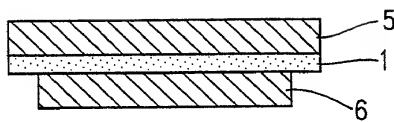
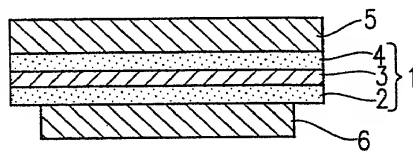
5 10. A workpiece retainer according to claim 6, wherein the side-chain crystallizable polymer has a melting point which occurs within a temperature range narrower than about 15°C.

10 11. A method for attaching/detaching a workpiece retainer according to claim 6 to/from a base plate of a polishing machine, comprising the steps of:

attaching the workpiece retainer to at least one of the workpiece and the base plate of the polishing machine maintained at temperature T1; and

15 detaching the workpiece from the base plate by heating the workpiece retainer at temperature T2 which is higher than temperature T1.

09756001-060407
104080-1009260

FIG. 1*FIG. 2*

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,
CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is for a national stage of PCT application PCT/JP99/04662.

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (*if only one name is listed below*) or an original, first and joint inventor (*if plural names are listed below*) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

WORKPIECE RETAINER AND METHOD FOR ATTACHING/DETACHING WORKPIECE BY USING
THE SAME

SPECIFICATION IDENTIFICATION

The specification of which was filed in the United States PCT Receiving Office on February 28, 2001
as Application Serial No. 09/786,001.

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified
specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37,
Code of Federal Regulations, § 1.56.

PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any
foreign application(s) for patent or inventor's certificate or of any PCT international application(s)

09786001-060401

designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

Such applications have been filed as follows.

**PRIOR FOREIGN APPLICATION(S) FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Japan	10-263751	17 September 1998	yes

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

James F. Haley, Jr.

Registration Number 27794

Lisa A. Dixon

Registration Number 40995

Nina R. Horan

Registration Number 47662

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:

James F. Haley, Jr.

c/o Fish & Neave

1251 Avenue of the Americas

New York, NY 10020

James F. Haley, Jr.

(212) 596-9000

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

1-0
Naoyuki Tani

Inventor's signature

Date 21 May 2001

Naoyuki Tani
Country of Citizenship Japan

Residence Nara, Japan

Post Office Address

SPX
c/o NITTA CORPORATION NARA FACTORY
172, Ikezawa-cho, Yamatokooryama-shi,
Nara Japan

7-0
Toshiaki Kasazaki

Inventor's signature

Date 21 May 2001

Toshiaki Kasazaki
Country of Citizenship Japan

Residence Nara, Japan

Post Office Address

SPX
c/o NITTA CORPORATION NARA FACTORY
172, Ikezawa-cho, Yamatokooryama-shi,
Nara Japan

3-0
Shinichiro Kawahara

Inventor's signature

Date 21 May 2001

Shinichiro Kawahara
Country of Citizenship Japan

Residence Nara, Japan

Post Office Address

SPX
c/o NITTA CORPORATION NARA FACTORY
172, Ikezawa-cho, Yamatokooryama-shi,
Nara Japan

09786004-060404
104090-1009260

4th

Takashi Ando

Inventor's signature

Takashi Ando

Date 21 May 2001

Country of Citizenship Japan

Residence Nara, Japan

SPF

Post Office Address

c/o NITTA CORPORATION NARA FACTORY
172, Ikezawa-cho, Yamatokooriyama-shi,
Nara Japan

5th

Masayoshi Yamamoto

Inventor's signature

Masayoshi Yamamoto

Date 21 May 2001

Country of Citizenship Japan

Residence Nara, Japan

SPF

Post Office Address

c/o NITTA CORPORATION NARA FACTORY
172, Ikezawa-cho, Yamatokooriyama-shi,
Nara Japan